

What is claimed is

1. A process for preparing 3-pentenenitrile, characterized by the following process steps:
 - 5 (a) isomerizing a reactant stream which comprises 2-methyl-3-butenenitrile over at least one dissolved or dispersed isomerization catalyst to give a stream 1 which comprises the at least one isomerization catalyst, 2-methyl-3-butenenitrile, 3-pentenenitrile and (Z)-2-methyl-2-butenenitrile,
 - 10 (b) distilling stream 1 to obtain a stream 2 as the top product which comprises 2-methyl-3-butenenitrile, 3-pentenenitrile and (Z)-2-methyl-2-butenenitrile, and a stream 3 as the bottom product which comprises the at least one isomerization catalyst,
 - 15 (c) distilling stream 2 to obtain a stream 4 as the top product which, compared to stream 2, is enriched in (Z)-2-methyl-2-butenenitrile, based on the sum of all pentenenitriles in stream 2, and a stream 5 as the bottom product which, compared to stream 2, is enriched in 3-pentenenitrile and 2-methyl-3-butenenitrile, based on the sum of all pentenenitriles in stream 2,
 - 20 (d) distilling stream 5 to obtain a stream 6 as the bottom product which comprises 3-pentenenitrile and a stream 7 as the top product which comprises 2-methyl-3-butenenitrile.
- 25 2. The process according to claim 1, wherein the reactant stream is obtained by the following process steps:
 - (e) hydrocyanating 1,3-butadiene over at least one hydrocyanation catalyst using hydrogen cyanide to obtain a stream 8 which comprises the at least one hydrocyanation catalyst, 3-pentenenitrile, 2-methyl-3-butenenitrile, 1,3-butadiene and residues of hydrogen cyanide,
 - 30 (f) distilling stream 8 once or more than once to obtain a stream 9 which comprises 1,3-butadiene, a stream 10 which comprises the at least one hydrocyanation catalyst, and a stream 11 which comprises 3-pentenenitrile and 2-methyl-3-butenenitrile,
 - 35 (g) distilling stream 11 to obtain a stream 12 as the bottom product which comprises 3-pentenenitrile, and a stream 13 as the top product which comprises 2-methyl-3-butenenitrile.

3. The process according to claim 2, wherein process step (d) and (g) are carried out in the same distillation apparatus, in which case streams 6 and 12 and streams 7 and 13 coincide.
- 5 4. The process according to either of claims 2 and 3, wherein process steps (c) and (g) are carried out in a common distillation column, in which case process step (d) is dispensed with, stream 2 from process step (b) and stream 11 from process step (f) are conducted into process step (g), and, in process step (g), stream 4 is obtained as the top product comprising (Z)-2-methyl-2-butenenitrile, stream 12 as the bottom product comprising 3-pentenenitrile and stream 13 as a side draw stream comprising 2-methyl-3-butenenitrile.
- 10 5. The process according to any of claims 1 to 4, wherein the at least one isomerization catalyst obtained in stream 3 in process step (b) is recycled into process step (a).
- 15 6. The process according to any of claims 1 to 5, wherein process steps (b) and (c) are carried out together in one distillation apparatus, in which case stream 3 which comprises the at least one isomerization catalyst is obtained as the bottom product, stream 4 which comprises (Z)-2-methyl-2-butenenitrile as the top product, and stream 5 which comprises 3-pentenenitrile and 2-methyl-3-butenenitrile at a side draw of the column.
- 20 7. The process according to any of claims 1 to 5, wherein process steps (a), (b) and (c) are carried out together in one distillation apparatus, in which case stream 4 which comprises (Z)-2-methyl-2-butenenitrile is obtained as the top product, and stream 5 which comprises 3-pentenenitrile and 2-methyl-3-butenenitrile at a side draw of the distillation apparatus, and the isomerization catalyst remains in the bottom of the distillation column.
- 25 8. The process according to any of claims 1 to 7, wherein the isomerization catalyst contains nickel(0), a trivalent phosphorus-containing compound which complexes nickel(0) as a ligand and, if appropriate, a Lewis acid.
- 30 9. The process according to any of claims 1 to 8, wherein pressure and temperature in process step (b) are set in such a way that the isomerization catalyst is less active than in process step (a) or is inactive.
- 35 10. The process according to any of claims 1 to 8, wherein the hydrocyanation catalyst and the isomerization catalyst are identical.

11. The process according to any of claims 1 to 10, wherein the reactant stream is obtained by the following process steps:

5 (a*) isomerizing a reactant stream which comprises 2-methyl-3-butenenitrile over at least one dissolved or dispersed isomerization catalyst to give a stream 1 which comprises the at least one isomerization catalyst, 2-methyl-3-butenenitrile, 3-pentenenitrile and (Z)-2-methyl-2-butenenitrile,

10 (b*) distilling stream 1 to obtain a stream 2 as the top product which comprises 2-methyl-3-butenenitrile, 3-pentenenitrile and (Z)-2-methyl-2-butenenitrile, and a stream 3 as the bottom product which comprises the at least one isomerization catalyst,

15 (c*) distilling stream 2 to obtain a stream 4 as the top product which, compared to stream 2, is enriched in (Z)-2-methyl-2-butenenitrile, based on the sum of all pentenenitriles in stream 2, and a stream 5 as the bottom product which, compared to stream 2, is enriched in 3-pentenenitrile and 2-methyl-3-butenenitrile, based on the sum of all pentenenitriles in stream 2,

20 (d*) distilling stream 5 to obtain a stream 6 as the bottom product which comprises 3-pentenenitrile and a stream 7 as the top product which comprises 2-methyl-3-butenenitrile,

25 (h*) catalyst regeneration to replenish the nickel(0) content of the substreams 14 from stream 3 and 16 from stream 10 to generate a stream 18,

30 (i*) if appropriate with addition of a diluent F to stream 18 to generate stream 19,

35 (j*) extracting stream 18, if appropriate stream 19, with regard to the catalyst components and/or disruptive component(s) by adding a dinitrile stream 20 and hydrocarbon stream 21 to generate two nonmiscible phases 22 and 23, stream 22 comprising the predominant proportion of the catalyst components and stream 23 the predominant proportion of the disruptive component,

40 (k*) distillatively removing the hydrocarbon from the catalyst components from stream 22 to generate a stream 25 which comprises the predominant proportion of the catalyst components and, if appropriate, partly or fully recycling stream 25 into process steps (a*) or (e*),

5 (e*) hydrocyanating 1,3-butadiene over at least one hydrocyanation catalyst using hydrogen cyanide to obtain a stream 8 which comprises the at least one hydrocyanation catalyst, 3-pentenenitrile, 2-methyl-3-butenenitrile, 1,3-butadiene and residues of hydrogen cyanide,

10 (f*) distilling stream 8 once or more than once to obtain a stream 9 which comprises 1,3-butadiene, a stream 10 which comprises the at least one hydrocyanation catalyst, and a stream 11 which comprises 3-pentenenitrile and 2-methyl-3-butenenitrile,

15 (g*) distilling stream 11 to obtain a stream 12 as the bottom product which comprises 3-pentenenitrile, and a stream 13 as the top product which comprises 2-methyl-3-butenenitrile.

12. The process according to claim 11, wherein the replenishment of the nickel(0) catalyst content is carried out in process stage h*) by reductive catalyst regeneration.

20 13. The process according to either of claims 11 and 12, wherein the catalyst system is operated as two separate catalyst circuits, one of the circuits including the stages e*) and f*) and the other circuit the stages a*), b*) and c*).

25 14. The process according to any of claims 11 to 13, wherein stabilizer-containing butadiene is used as the feed stream to e*).

15. The process according to any of claims 11 to 14, wherein the catalysts used are phosphites of the formula I b

30 $P(O-R^1)_x(O-R^2)_y(O-R^3)_z(O-R^4)_p$ (I b)

where

35 R¹: aromatic radical having a C₁-C₁₈-alkyl substituent in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system, or having an aromatic substituent in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system, or having a fused aromatic system in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system,

40 R²: aromatic radical having a C₁-C₁₈-alkyl substituent in the m-position to the oxygen atom which joins the phosphorus atom to the aromatic system, or

5 having an aromatic substituent in the m-position to the oxygen atom which joins the phosphorus atom to the aromatic system, or having a fused aromatic system in the m-position to the oxygen atom which joins the phosphorus atom to the aromatic system, the aromatic radical bearing a hydrogen atom in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system,

10 R³: aromatic radical having a C₁-C₁₈-alkyl substituent in the p-position to the oxygen atom which joins the phosphorus atom to the aromatic system, or having an aromatic substituent in the p-position to the oxygen atom which joins the phosphorus atom to the aromatic system, the aromatic radical bearing a hydrogen atom in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system,

15 R⁴: aromatic radical which bears substituents other than those defined for R¹, R² and R³ in the o-, m- and p-position to the oxygen atom which joins the phosphorus atom to the aromatic system, the aromatic radical bearing a hydrogen atom in the o-position to the oxygen atom which joins the phosphorus atom to the aromatic system,

20 x: 1 or 2,

y, z, p: each independently 0, 1 or 2, with the proviso that x+y+z+p=3.

16. The process according to any of claims 11 to 15, wherein the catalysts used are 25 phosphites of the formula I b



30 where R¹, R² and R³ are each independently selected from o-isopropylphenyl, m-tolyl and p-tolyl, R⁴ is phenyl; x is 1 or 2, and y, z, p are each independently 0, 1 or 2, with the proviso that x+y+z+p = 3; and mixtures thereof, i.e. mixtures of 2 or more, preferably from 2 to 10, more preferably from 2 to 6, of the compounds of the formula I b.